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ABSTRACT

Whether additional cues in visualized materials add to their instructional value is a question answered differently by various educational theorists. In the eight studies reviewed, experiments were designed to answer this question and other questions related to it. In three media studies using the same four treatments (oral presentation without visuals, with line drawings, with shaded drawings, and with color photographs), line drawings were most effective in the slide study oral presentation in the videotape study, and relaistic photographs in the programed instruction study. In another study, nine slide treatments having various types of visual illustrations were administered to 1054 high school students. Results indicated that at certain grade levels, color is an important instructional variable. Three later studies using a videotape of the nine slide presentations on 22-inch monitors, on a 5 by 3-foot front projection image, and on a 6 by 4-foot rear screen image found that students viewing the smaller images did better than those viewing images on the large screens. To summarize: where time is unlimited, simple line drawings are preferable; where time is determined by the students, as in programed instruction, more detailed presentations have greater learning value. (MF)

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Exploratory Studies in the Effectiveness of Visual Illustrations

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Introduction

Much has been written about the uses and advantages of the visual medium for instructional purposes. Little has been done, however, to identify which physical characteristics contained within the various types of visual illustrations are most efficient in facilitating student achievement of different types of educational objectives. Since we do not have definite rules or principles which will enable a teacher to select the type of visual illustration most appropriately suited for instruction, it seems evident that the instructional media which depend primarily upon the visual channel would profit from a program of systematic evaluation. This evaluation should be focused on the relative effectiveness with which the different types of visuals, possessing varying amounts of realistic detail, facilitate student achievement of specific educational objectives. Allen (1960), Hoban (1960), and Schramm (1960) have stated that extensive research needs to be conducted on the physical characteristics inherent within pictorial illustrations that lead to increased learning and to the attainment of specific educational objectives.

Related Literature

One assumption regarding the production of visualized materials which currently seems to be prevailing contends that the more realistic a presentation, the more effective will be the transmission of the desired message. Finn (1953) and Dale (1946) have recommended that for instructional purposes the more realistic or life-like the stimulus material is, the greater the probability it has for facilitating learning. Several theoretical orientations have been developed out of this point of view: specifically, the iconicity theory identified by Morris (1946), the sign similarity orientation developed by Carpenter (1953), the theory of pictorial perception proposed by Gibson (1954), and Dale's (1946) cone of experience. The basic assumption held by each of the proponents of the above realism theories is that learning will be more complete as the number of cues in the learning situation increases.

However, there is other theory and research suggesting that this assumption underlying the realism theories may be a tenuous one as best. Miller, et. al. (1957) have stated that it would be a mistake to assume that one cue added to another would increase learning by a linear increment. Their contention is that additional cues or excessively realistic cues may be distracting or possibly evoke competitive responses in

opposition to the desired learning. Such cues would be considered interference and would reduce rather than facilitate learning. Accordingly, Bruner, et. al. (1956) and Travers, et. al. (1964) have suggested that learners do not need a wealth of stimuli in order to recognize the attributes of an object or situation which place it in a particular category. Travers, et. al. (1964, p. 1.18) feel that the realistic presentation of much content provides unnecessary detail and that the real objective of visual education is "not so much to bring the pupil into close touch with reality, but to help students become more effective in dealing with reality." Travers and his associates feel that this can be done effectively by symbols. Broadbent (1958, 1965) has explained that the reduction of learning as the cue stimulation increases as caused by the filtering process in the central nervous system which prevents many of the realistic stumuli from receiving active reception in the brain. Jacobson (1951a, 1951b) supports this point of view and states that the brain is capable of utilizing only minute proportions of the information perceived. Research by Livingstone (1958, 1959, 1962) indicates that receptor sensitivity to stimuli may be reduced or inhibited by processes of the central nervous system.

Attneave (1954) conducted research guided by the hypothesis that one function of the perceptual machinery was to reduce redundant stimulation and to encode incoming information so that only the essentials travel through the central nervous system to the brain.

In summary, there is theory and research which indicates that presenting realistic presentations is not necessarily the most effective way to facilitate learning. Therefore, educators should attempt to identify those particular characteristics within different types of visuals that function to facilitate sutdent achievement of different educational objectives.

Specific Objectives

The several studies cited in this article evolved from an attempt to determine the instructional effectiveness of different types of visual illustrations used to complement and to visualize oral and verbal instruction. The followigg are some of the questinos which provided the general orientation in the several studfes:

1. Will the use of visual illustrations designed to complement oral and verabl instruction improve student achievement?
2. Are all types of visuals equally effective in facilitating student achievement of all types of learning objectives?

3. Is color in visuals an important instructional variable in facilitating student achievement of specific objectives?

4. Will the use of visuals to complement oral instruction affect delayed retention of the content material?

5. Does the method in which visuals are presented to students affect their ability to facilitate achievement?

Instructional Materials

In an attempt to answer the cited questions a 2000-word instructional unit on the human heart was developed. The script described the heart, its parts, and the internal processes which occur during the systolic and diastolic phases. This content was selected because it permitted the evaluation of several learning objectives. In each study, students received the same instructional unit and were evaluated by the same criterial tests. This procedure was followed in order to permit comparisons among the several studies.

Criterial Measures

In order to determine what types of visuals are most effective in promoting student achievement of specific educational objectives, four individual criterial measures were developed.

Drawing Test

The drawing test (N=18 items) provided the students with a list of specific terms corresponding to the parts of the heart discussed in the instructional unit. The students were required to draw a representative diagram of the heart and place the numbers of the listed parts in their respective positions. For this test the emphasis was on the positioning of the verbal symbols with respect to their concrete referents.

Identification Test

This multiple choice test (N=20 items) required students to identify the numbered parts on a detailed drawing of a heart. Each part of the heart which had been discussed in the instruction was numbered on the drawing and appeared in a list on the answer sheet. The objective of this test was to measure the student's ability to identify numbered parts of the heart from information received in the instruction.

Terminology Test

This test (N=20 items) consisted of a series of fill-in questions; it was possible for one and only one specific answer to be correct. This test evaluated student knowledge of specific symbols.

Comprehension Test

The comprehension test consisted of 20 multiple-choice items. Direct reference was made to the location of specific parts of the heart while functioning. The student then was asked to identify the position that other specified parts of the heart would be occupying at that particular moment. This test required that the student have a thorough understanding of the heart, its parts, its internal functioning, and the simultaneous processes occurring during the systolic and diastolic phases. The comprehension test was designed to measure a type of understanding that occurs when the individual understands what is being communicated and can use the information being received to explain some other phenomenon occurring simultaneously.

Total Criterial Test

The items contained in the four individual criterial tests were combined into a 78-item total criterial test. The purpose of this test was to measure the student's total understanding of the information presented.

Review of Studies

For the initial study (Dwyer, 1967a), four slide sequences were designed, each containing 39 slides. Each

slide was designed to illustrate a specific item of information described in the oral instruction. Each sequence displayed relatively the same information, the slides differing only in the amount of detail they contained. For this first study the heart script was audiotaped. The oral and visual presentations were synchronized so that the appropriate visuals appeared simultaneously with the oral instruction they were designed to complement. In this study students viewed their respective treatments for equal amounts of time.

Students in treatment I, the control group, received the oral presentation without visuals of the heart. Students in treatment II received simple line drawings to complement the oral instruction. Students in treatment III viewed detailed, shaded drawings, and students in treatment IV viewed realistic photographs of a heart specimen.

The results* of this study indicated that when students viewed their respective instructional presentations for equal amounts of time, the simple line drawing presentation, treatment II, was significantly more effective (.01-level) than the other treatments in promoting student achievement on the drawing, identification, and total criterial tests. Treatment I, the oral presentation,

*All analyses in this report are made in terms of instructional effectiveness and economy in production of the visual materials.

was as effective as each of the visually complemented treatments on both the terminology and comprehension tests.

In a different study (Dwyer, 1968a) the same four instructional treatments were videotaped and presented to college students via conventional 22" television monitors. The results indicated that treatment I, the oral presentation without visuals, was as effective as the visually complemented treatments on four of the five criterial tests. The exception was the drawing test in which the simple line drawing presentation was found to be significantly more effective (.01-level) than the oral presentation in facilitating student achievement.

Several explanations may be advanced to explain the results obtained in this study.

1. Since college students are generally selected from the upper two-thirds of the population in terms of verbal and conceptual ability, it may be that they are in a highly favorable position in terms of being able to learn from oral instruction. If this assumption is accurate, then the use of visual illustrations is not necessary to complement oral instruction designed to promote learning objectives similar to those measured by the identification, terminology, comprehension, and total criterial tests.

2. The realistic detail contained within the visual illustrations used to complement the oral instruction may have had the net effect of distracting the attention of the students from the essential learning cues, thereby interfering with rather than facilitating achievement.

3. Since students in each treatment group viewed their respective televised presentations for equal amounts of time, those students who viewed the more realistic types of visuals may not have had sufficient time to study and comprehend adequately the additional information contained in the visual illustrations presented to them.

In a third study involving college students (Dwyer, 1967b) the heart script was put in a programed format. Each programed booklet contained 37 paragraph-type frames on 5 1/2 x 8 1/2-inch sheets. 2 1/2 x 3 1/2-inch illustrations were made from slides used in the two studies previously mentioned. These illustrations were placed on the programed frames containing the information they were designed to illustrate. In this study students were permitted to view their instructional treatments for as long as they felt necessary to comprehend the material being presented.

The results of this study indicated that the use of visual illustrations to complement programed instruction is an effective way to improve achievement of those educational objectives measured by the drawing (.01-level), identification (.05-level), and total criterial (.05-level) tests. However, the level of achievement of students

receiving the programed presentation without visuals was equal to that of those who received the visually complemented treatments on the terminology and comprehension tests. Apparently the use of visuals to illustrate programed content will not improve student achievement of all those educational objectives measured by the criterial tests used in this study.

Table 1 provides a summary and comparison of the results obtained in the three studies just cited. On the extreme left of Table 1 are listed the three methods of presentation: slides, television and programed instruction. On the extreme right of the table is the amount of time students were permitted to interact with their instructional presentation--40 minutes for the slide presentation, 17 minutes for the televised presentation, and 22 minutes for the programed study which is the average amount of time required by students to work through their instructional booklets.

Table 1.

Instructional Presentations Found Most Effective

Criterial Tests / Instructional Method	Drawing Test	Ident. Test	Term. Test	Comp. Test	Total Criterial	Time
Slides (Dwyer, 1967a)	Simple line pres.	Simple line pres.	Oral	Oral	Simple line pres.	40 min.
Television (Dwyer, 1968a)	Simple line pres.	Oral	Oral	Oral	Oral	17 min.
Programed Instruction (Dwyer, 1967b)	Realistic Photographs	Realistic Photographs	Programed Instruction		Realistic Photographs	Average 22 min.

In the three studies students received the same instructional content but through different methods of presentation. If we compare the results obtained from the slide study with the results obtained from the programed instruction study (See Table 1), we find that the same objectives--as measured by the drawing, identification and total criterial tests--were facilitated by the use of visuals, but by different types of visuals. In the slide study, the simple line illustrations were found to be most effective in facilitating student achievement. However, in the programed instruction experiment

the presentation containing the realistic photographs was found to be most effective in facilitating student achievement.

In comparing the results of the slide study with the television study we will notice that the instructional period has been reduced from 40 to 17 minutes--greater than a 100% reduction. This reduction in the amount of time students were permitted to interact with the visualized presentation in the television study also reduced the effectiveness with which visuals facilitated achievement on two criterial tests--the identification and total criterial tests.

A more comprehensive approach to the evaluation of the effectiveness of various types of visual illustrations involved the production of five additional slide treatments, each containing 39 slides: simple line drawing presentation (color), detailed, shaded drawing (color), heart model (black and white), heart model (color), and realistic photographs of heart specimens (color). The nine slide treatments were administered to 1054 students in the 9th, 10th, 11th and 12th grades (Dwyer, 1969a, 1968b, 1968c, 1969b). Again, slides were synchronized with the oral instruction which was presented by means of audiotape. Students also received the same criterial tests. In addition to the immediate testing, delayed retention was measured two weeks later using the same tests. A number of summary statements can be made regarding the cited studies: (a) the same type of visuals are not equally effective at different grade levels in facilitating student achievement of objectives measured in this

study, and (b) for specific objectives and for students in certain grade levels, color appears to be an important instructional variable for improving student achievement.

In general, the differential effects attributed to the different visualized treatments disappeared on the delayed retention tests for the four grade levels. Considerable caution should be exercised in interpreting this finding. Further research is needed in which the time lapse between the immediate and delayed testing sessions is increased to four, eight and twelve weeks, and longer, if possible, before any definite conclusions can be made regarding the use of visual illustrations to promote increased student retention.

In another study involving college students (Dwyer, 1968d), the instructional content was used in the programed format. 2 1/2 x 3 1/2-inch photographs were made from the slides used in the nine instructional treatments cited in the previous studies. These illustrations were placed on the programed frames they were designed to complement and presented to students in booklet form.

The results of this study (Table 2) indicate that: (a) the simple line presentation (B&W) was most effective (.01-level) in promoting student achievement on the drawing test; (b) the programed presentation without visuals should be used to promote student ahcievement of those objectives measured by the terminology and comprehension tests; and (c) the heart model presenta-

tion (color) was most effective (.05-level) in promoting student achievement of those objectives measured by the identification and total criterial objectives measured by the identification and total criterial tests.

Table 2

Presentations Most Effective in Facilitating Achievement On Each Criterial Measure in the Programed Study (Dwyer, 1968d)

Criterial Measures	Instructional Presentations
Drawing Test	Simple Line Presentation (B&W)
Identification Test	Heart Model Presentation (Color)
Terminology Test	Programed Presentation without visuals
Comprehension Test	Programed Presentation without visuals
Total Criterial	Heart Model Presentation (Color)

An explanation may be advanced for the failure of the visually complemented presentations to facilitate achievement on the terminology and comprehension tests. It may be that the type of achievement measured by these two criterial tests did not require the students to utilize the information contained in the illustrations.

The effectiveness of the colored version of the heart model presentation may be explained by the fact that the realistic detail in the visuals was accentuated by color. Consequently, students were better able to make the appropriate discriminations and to obtain the necessary information required to achieve on these tests.

The next three studies involved television and may be brouped together and classified as replication with variation. The five black and white slide treatments were videotaped for these studies, i.e., the oral presentation without visuals, the simple line presentation, the detailed, shaded drawing presentation, the heart model presentation, and the realistic photographic presentation.

In the first study (Dwyer, 1968a) students viewed their instructional treatments on 22" monitors; in the second study (Dwyer, 1969c), by means of a telebeam projector producing a 5' x 3' front projection image; and in the third (Dwyer, 1970), by means of a telebeam projector producing a 6' x 4' rear screen image.

In each of the three studies (Dwyer, 1969d) the same results occurred (Table 3). The oral presentation without visuals was found to be as effective as the visually complemented treatments on four of the five criterial tests. The exception was the drawing test, for which in all three studies the simple line presentation was significantly more

effective (Study I: .01-level; Study II: .05-level; Study III: .05-level) than the oral presentation in facilitating student achievement.

Table 3.

Presentations Most Effective in Facilitating Achievement On Each Criterial Measure for the Television Studies

Criterial Measures	Instructional Presentations
Drawing Test	Simple Line Presentation
Identification Test	Oral Presentation
Terminology Test	Oral Presentation
Comprehension Test	Oral Presentation
Total Criterial Test	Oral Presentation

The data from the three television studies was analyzed across the studies comparing the achievement of the students receiving their instruction via 22" monitors with the achievement of those students receiving identical instruction on the 5' x 3' front projection and the 6' x 4' rear projection screens. That is, the effectiveness of the same visuals on viewing areas of different sizes were compared (Table 4).

Table 4.

Analysis of the Effectiveness of Visual Presentations of Different Sizes

Treatments / Criterial Tests	Oral Pres.	Simple Line Pres.	Detailed Shaded Drawing Pres.	Heart Model Pres.	Realistic Heart Photograph Pres.
Drawing Tests	I III (.01-level)	I III (.05-level)			
Identification Test	I III (.05-level)	I II (.05-level)	I III (.05-level)	I II (.05-level)	
Terminology Test					
Comprehension Test					
Total Criiterial					

Table 4 indicates where significant differences in achievement occurred among students in the different studies. Students receiving instruction in Study I by means of the 22" monitors achieved significantly higher scores on the drawing and identification tests than did students receiving the same instruction on the larger viewing areas. The blank squares indicate that significant differences in achievement did not occur among students viewing their presentation via the larger viewing areas.

The data indicated that merely increasing the size of instructional illustrations by projecting them on larger viewing areas does not automatically improve their instructional effectiveness. In fact, for certain learning objectives the use of the larger images inhibited student achievement. The results indicated that where significant differences occurred, the instruction presented via the 22" monitors was most effective in promoting student achievement.

The success of the instruction presented on the 22" monitors may be explained by the fact that the smaller visuals had greater definition and presented more clearly the information needed by students to achieve specific objectives. When these same visuals were expanded on the larger screens, a deterioration of the picture quality resulted. It may also be that the increased size of the visual images required students to spend more time scanning the larger viewing area for the relevant visual cues being discussed orally. The more time students spent looking for the relevant cues meant that they had less time to interact with them once they were located. Apparently the opportunity to perceive and to interact with the relevant characteristics in visuals are prerequisites for optimum visual learning.

Summary

In the studies cited two basic methods of presenting visualized instruction were employed. The first can be characterized as a group learning situation (i.e., students received instruction via slides and television where instruction was externally faced. In this method all students received the same instruction for the same amount of time. The implied assumption is that all students perceive the same thing at the same time, and that all students in a group learning situation learn at the same rate. The results of the studies evaluating visualized instruction presented in this manner indicated, in general, that where the use of visuals did make a difference in increasing student achievement those illustrations containing relatively small amounts of realistic detail were most effective. These results may be attributed to the fact that students viewed their respective types of visual illustrations for equal amounts of time. If we can assume that the accuracy and the amount of information that can be perceived in a visual depends on the amount time available for viewing them, then the more realistic presentations would be at a disadvantage. Even though the more realistic visual illustrations contained more essential information than did the less realistic illustrations, the students did not have sufficient time to take full advantage of the information provided by the

additional realistic detail. It may also be suggested that the additional detail contained in the more realistic illustrations distracted student attention from important information presented in the oral instruction or important visual cues in the illustrations, thereby reducing their effectiveness as efficient learning media.

The second learning situation (programed instruction) can be described as one which facilitates the individualized learning process. Here instruction is internally paced in that the student proceeds through the content material at his own rate. Results of these studies indicated that where the use of visuals did make a difference in increasing student achievement the more realistic illustrations were most effective. These results may be explained by the fact that students were permitted to interact with the more realistic illustrations for as long as they felt necessary to complete their understanding of the information being presented. Since these illustrations contained more detail than the simplified illustrations, students were better able to interact and absorb essential information which in turn enabled them to make more appropriate discriminations on the criterial tests. Since the less realistic presentations (simple line drawings, detailed shaded drawings, etc.) actually contained less information, students were limited in the amount of information they could extract from them

regardless of the length of time that they were available for study.

While maintaining awareness of the methods of presentation (slides, programed format, television), specific content material, and type of criterial measures employed, a number of generalizations can be made which may be helpful in guiding the production and use of visual illustrations used for instructional purposes:

1. The use of visuals to complement oral and verbal instruction does not automatically improve student achievement.

2. Different visuals differ in the effectiveness with which they promote achievement of learning objectives.

3. The effectiveness of specifications of visual material depends on the method utilized to present this material to the student.

4. For students in different grade levels, the same visuals are not equally effective in increasing student achievement of identical objectives.

5. For specific objectives the addition of color in certain types of visuals, for students in specific grade levels, appears to be an important instructional variable in improving student achievement.

6. The effectiveness of a particular visual in facilitating student achievement of a specific objective depends on the type of information needed by the student to achieve that objective.

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